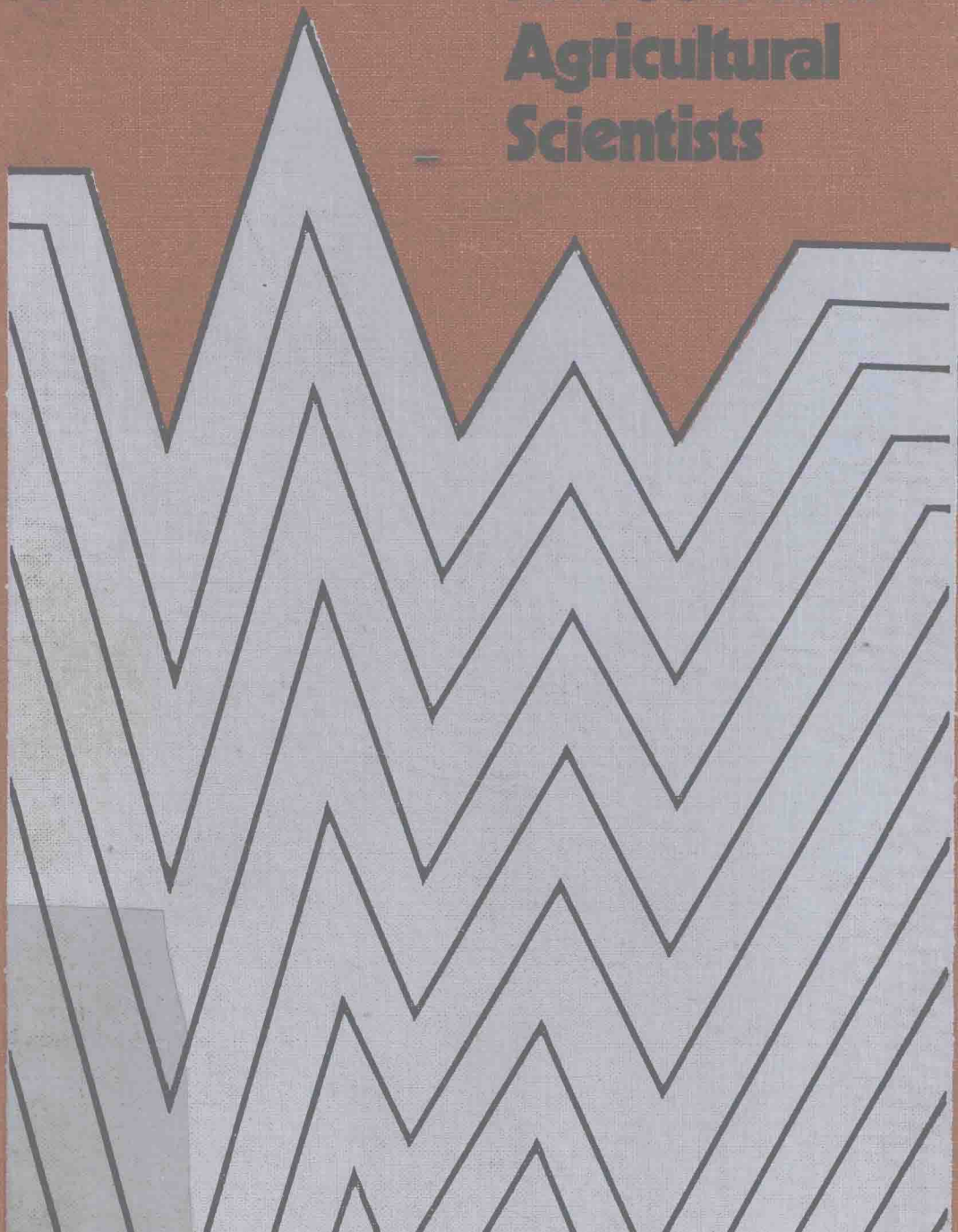


Subhash C. Puri  
Daniel Ennis  
Kenneth Mullen

**Statistical  
Quality Control  
for Food and  
Agricultural  
Scientists**



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# **Statistical Quality Control for Food and Agricultural Scientists**

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*To Shashi, Tricia, & Tony*

# Foreword

Recent advances in statistics indicate a very active field of research, and interesting developments are occurring in many areas of the subject. One general area of particular interest is that of applications, which in theory should facilitate the interaction of statistics with the other sciences. Unfortunately, in work of this nature, difficulties frequently arise because of the narrow specialization of individual scientists, and consequently other scientists often are not able to follow the jargon and thinking of statisticians, while statisticians are frequently not able to understand the difficulties of experimental work in other areas.

The present book attempts to avoid these difficulties and aims to reach both types of audiences; that is, it should be of interest to statisticians in outlining areas where statisticians can make useful contributions, and also to a wide range of other scientists by enabling them to appreciate the contributions which statisticians can make.

Specifically, the aims of the book are limited and deal with the subject of statistical quality control. This is a field which has reached a stage where it has an identity of its own, and which also has extended its applications to many scientific investigations, both in the industrial and nonindustrial areas. A

number of books have previously been written on the subject of statistical quality control, but most of them deal with applications in the field of industrial engineering. This book is perhaps the first of its kind to explain the need of statistical quality control in food and agricultural products and processes, while at the same time outlining the general methods of statistical quality control which may be applied to other fields.

The three authors have considerable experience, both as University teachers and also in government, specifically in dealing with “real world” problems, and in this way represent a combination of talents which should prove successful in writing a book along the lines outlined above. The undersigned is honored to have been asked to write this Foreword, and hopes that this book and others of its kind will be widely used and assist in a variety of multidisciplinary studies, which are likely to assume an increasing importance in the future.

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# Preface

The book is intended to be a practical working manual. It is hoped to be straightforward enough to be used by a food or agricultural scientist and mathematical enough to be used as a text for a course at a university or college. The book may therefore be useful to food scientists and researchers, quality control managers in food industries, food producing agencies, government departments associated with regulation of food and agricultural products, universities and colleges, and in general for all persons concerned with the control of quality of food and agricultural products, or for persons contemplating careers in these areas.

As described in Chapter 2 of the book, the whole question of quality is looked at as part of a total management system, and the salient features of a total quality control system are also described in this chapter. It is noted that once the product/process is quality-controlled through a total quality management program, there are essentially two important aspects of quality that need to be investigated: sampling inspection procedures and methods of process control. The sampling inspection requires the appropriate selection of a sampling plan, and a suitable method of selecting the sample. These aspects are described in Chapters 4 and 5, and the various

control chart methods for controlling the process are provided in Chapter 6. Since a basic understanding of the concept of statistical techniques is essential for the comprehension of statistical quality control methods, Chapter 3 has been included for this purpose. In this way it is hoped that the essential elements of statistical quality control have been covered in a compact and readable manner.

We wish to thank all those who helped in the preparation of this book. We are particularly grateful to Steve Brown, Elaine Hoskins, and Denis Laferrière for their helpful suggestions and comments, to many authors whose material we have quoted or paraphrased, to G. K. Hall & Co. for their help and cooperation, and to our wives and children for their patience and encouragement.

We are also indebted to Professor E. S. Pearson and the Biometrika Trustees for permission to use Tables from Biometrika Tables for Statisticians, volume 1.

S. C. Puri  
D. Ennis  
K. Mullen



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# 1

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## Introduction

### 1.1 Background

People have probably been concerned about product performance since the first Stone Age implement was created. Concern for performance or quality relative to preset specifications has been seen throughout history. Early Greek philosophers recognized the importance of individual excellence in producing goods or providing services, and a yearning for quality performance led to division of labor. Special care was taken during the Middle Ages to ensure that the work of master craftspeople met the high standard required of their profession. With the onset of the industrial revolution, manufacture and distribution of goods became more impersonal, with a concurrent lack of interest in excellence for its own sake. It was not until 1924, when Walter A. Shewhart constructed the first control chart, that statistics were applied to control product quality. Unfortunately, quality control techniques did not develop very rapidly in the United States until World War II, although statistical quality control techniques were in fairly general use in Britain by 1937.

Quantitative methods have become an integral part of every total quality control program. Total quality control im-



plies a total management system for the coordination and integration of all functions of quality, such as quality control, quality assurance, and quality reliability, that are pertinent to the development of a superior product. We shall use the term “total quality control,” or simply quality control, to indicate most of the activities and functions related to quality.

For the first several years since its inception as a specific science, quality control had rather a limited area of application—mostly to engineering problems. Today statistical quality control plays a significant role in virtually every activity, industrial or nonindustrial, that needs a scientific method of analyzing data to solve practical problems. For example, it is successfully employed in food and agricultural production, medical and pharmaceutical products, financial and personnel management, or general management, and in several governmental departments.

### **1.2 Three Parties: Producer, Inspector, Consumer**

Three parties are involved with quality control—the producer, the regulatory agency (governmental or otherwise), and the consumer. The collective satisfaction of all parties produces an optimal state of product quality. Each party has an important function to perform, and contributes toward bringing forth a product of superior quality. Sometimes the importance of the inspection agency is underestimated and is not even mentioned as a party to the function of quality control. The producer has to deliver a good quality product in accordance with design specifications, as well as to provide a continuing assurance to the customer that the accepted product is at a level of quality the customer reasonably expects. The product has to be satisfactory, dependable, and economical. A regulatory agency must carry out sampling inspection, grading, and monitoring to ensure that the product meets the specifications, standards, and tolerances. The inspection agency helps the producer know the true state of product quality and helps the consumer receive an acceptable prod-